Browning Reactions, Sugars & Sweeteners

I. Introduction

A. Enzymatic or oxidative browning

1. Enzymatic or oxidative browning requires three factors:

- Substrate (usually polyphenolic compounds in foods)
- Enzyme (phenolase enzyme)
- Oxygen

2. Methods used to reduce enzymatic browning include:

- Low temperatures to slow reaction
- Denature enzyme with heat
- Low pH
- Chelation to tie up a mineral (like copper) that is part of the enzyme's molecular structure
- Exclude oxygen
- Use an oxygen scavenger like ascorbic acid to reduce quinones back to polyphenols before they can polymerize and result in browning
- Bisulfites were historically used to inhibit browning. These compounds worked well, but are no longer used in most food products because some individuals have allergies to sulfites.

3. Purpose of Experiment

- Demonstrate nonenzymatic (carbonyl amine or Maillard) browning in solutions contain reducing (glucose and fructose) and nonreducing (sucrose) sugars
- Observe enzymatic browning reactions and treatments used to minimize the reactions

B. Nonenzymatic

1. (Maillard or carbonyl-amino) Browning

a. Required components

- Reducing sugar
- Free amino or protein group

b. Involves multiple reactions

c. pH, temperature, moisture content, water activity,

specific sugars and amino acids available affect flavor and color development.

d. Purpose Of Experiment

To demonstrate Maillard-type browning in solutions containing lysine and different sugars.

2. Caramelization (sugar browning)

a. does not require nitrogen or any other non-sugar reactant

b. can involve any kind of sugar

c. requires very high temperatures (> melting point of sugar)

d. involves dehydration reactions that result in polymerized brown

compounds.

e. Purpose of experiment

To demonstrate caramelization as a dehydration reaction

Note: Fresh onions contain a high percentage of soluble sugars. The main one is sucrose.

3. Ascorbic Acid Browning

a. catalyzed by metals

b. involves degradation of ascorbic acid

c. often seen in lemon juice

a. no experiment in this lab

A. Sugars and Sweeteners

1. Sugars differ in sweetening ability

Compound	Relative Sweetness
Sucrose	*1.0*
Lactose	0.27
Maltose	0.5
Sorbitol	*0.5*
Galactose	0.6
Glucose	*0.5 - 0.7*
Mannitol	0.7
Glycerol	0.8
Fructose	*1.1 - 1.5*
Saccharin	500 - 700
Aspartyl-phenylalanine methylester	100 - 200
Stevioside	300
Acesulfame Potassium *	200
Sucralose *	600
Alitame *	2000

Solms, J. 1971. Nonvolatile compounds and the flavor of foods. In Gustation and Olfaction, G. Ohloff, and A.F. Thomas (Editors). Academic Press, New York

* Calorie Control Council www.caloriecontrol.org).